

Three-Dimensional Simulations of Polar Stratospheric Cloud Formation

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Clouds composed of water ice and nitric acid form in the stratosphere over the Antarctic and Arctic during wintertime. These clouds have been definitively linked to ozone destruction due to heterogeneous chemical reactions on the particle surfaces. This process leads to the ozone hole over the Antarctic, and several studies have suggested the relatively minor ozone loss over the Arctic may worsen in the future.

A three-dimensional (3-D) model for simulation of these polar stratospheric clouds (PSCs) has been developed. With this model, calculations of the PSC properties and their effects over the entire hemisphere can be made. The model is driven by measured wind fields and temperatures. Microphysical processes are explicitly calculated, with 20 size bins for sulfate aerosols and cloud particles. The figure shows a snapshot of PSCs simulated during the Arctic winter of 1999/2000 during the NASA Stratospheric Aerosol and Gas Experiment (SAGE) III Ozone Loss and Validation Experiment (SOLVE). Validation of the simulations using aircraft and satellite measurements made during SOLVE is being done. The 3-D simulations are being used to calculate the vertical redistribution of nitric acid over the entire Arctic.

Preliminary modeling results suggest that the net removal of nitric acid is relatively insensitive to the threshold conditions for PSC

formation assumed. The 3-D model is also useful for providing a large-scale context for the localized in situ aircraft measurements. This modeling tool is expected to be useful for analysis and interpretation of future satellite measurements of PSCs.

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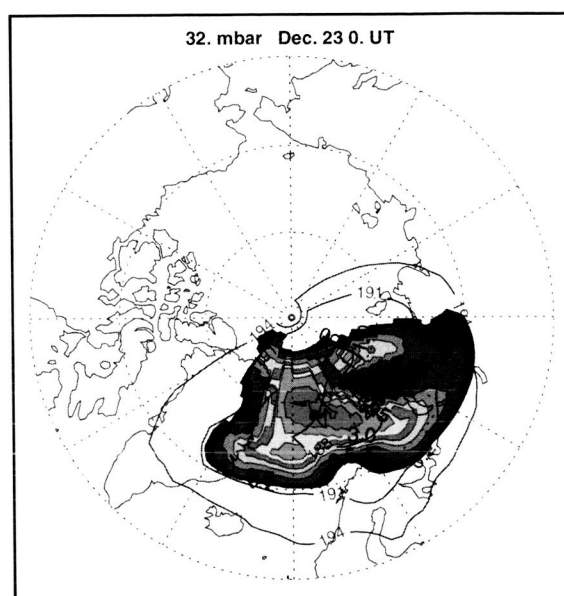


Fig. 1. Results from a three-dimensional simulation of Arctic PSCs during the winter of 1999–2000. Condensed nitric acid mixing ratio (color shading, parts per billion by volume) and temperature (red contours) are shown on the 32 millibar (mbar) pressure level, on December 23. The model indicates a large PSC extending from eastern Greenland over northern Russia.